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A PROJECT BOOK

Making Model Ships

PROJECT BOOK 194

TOYS AND MODELS

over

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PROJECT BOOKS

continued on P. 64

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TOYS AND MODELS

A PROJECT BOOK

Making Model Ships

PROJECT BOOK 194

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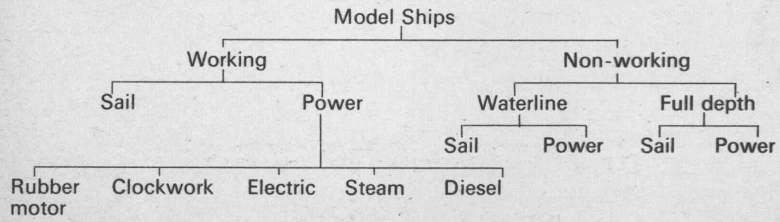
PART ONE

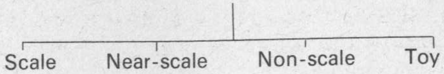
Choosing your first model

You are going to build your first model ship. Perhaps you already have some idea of what kind—a power-driven liner speeding across a pond, a plastic galleon frozen in full sail on your bookcase, a submarine which dives and re-surfaces, or the ultimate in models, a radio-controlled boat. You possibly think that there are a dozen types of model you can choose from. Dozen? There are nearly a hundred.

For a start, model ships are either *working* (they float and can travel under sail or power); or *non-working* (like a plastic kit model). Working models can be sail or power. Non-working models can either look like a ship afloat when they are stood on a flat surface (*waterline* models); or like a ship ashore with a *full depth* hull. We can start to draw a 'family tree' of model ships like this:



We can go on from there. Each type of model may be a scale model, or not. If not, it may be near-to-scale (near-scale); not to scale at all (just a working model); or perhaps simply a toy. Thus each of the ten types in the 'family tree' have further branches like this:



PROJECT

Working to scale

Scale really means comparison of size. If a model ship is 1 ft. long and the full-size ship is 100 ft. long, the model is 1/100th the size of the full size ship, so the scale is 1/100. There is no 'standard' scale for model ships because the size of full-size ships varies so much. If we kept to 1/100 scale, for example, a model of a speedboat would be about $2\frac{1}{2}$ in. long and a model of a liner up to 10 ft. long. The model speedboat would be far too small to make a working model—and you would not have room to keep the model liner in your room. So the actual length of a model is more important than its scale, especially for a working model.

Scale is important when you are making a collection of scale models. To be realistic they should all be to the same scale, or at least model ships of the same type should be to the same scale. This is done in the case of plastic kits, where a series of models are produced to the same scale.

PROJECT

Start taking notes

Keep a notebook of plastic model ship kits. List the names of the models available under different types and the scale. If this is not given on the catalogue or leaflets describing the kits, you can ask the model shop what the scale is. You will then have a guide as to what plastic kit models go together in a scale collection.

Sometimes you may have to work out the scale by measuring the length of the model and comparing it with the length of the full-size ship. This figure you may have to find by looking it up in a book on ships in your school library or local library. The length of the full-size ship will be given in feet, but you will measure the length of the model in inches.

PROJECT

Find the scale

To find the scale, divide the full-size length by the model length, and then multiply by 12. Example: the full-size ship is 464 ft. long, and the model is 11 in. To find the scale we divide

$$464 \text{ by } 11 = 42\tfrac{2}{11}$$

and then multiply by 12

$$12 \times 42\tfrac{2}{11} = 506\tfrac{2}{11}$$

It will be good enough to call this 500, or the scale 1/500. To make it easy, in fact, we can ignore fractions in dividing.

Scale does not really matter with a working model, unless you are building a fleet of working models of the same type. Instead it is best to work to a suitable *length*, depending on the power to be used. Here are some typical sizes:

Clockwork-powered models—usually from about 6 in. to 12 in. long, seldom bigger because clockwork motors are not very powerful.

Electric-powered models—9 in. to 12 in. long for models using the smallest size of electric motors, up to about 24 in. long. Larger models need more powerful, and fairly expensive motors.

Diesel-powered models—about 15 in. is the smallest size, but most models of this type are from 24 in. to 36 in. long. Larger models need big, expensive engines.

Model Yachts—anything less than about 12 in. long is really a toy. A model yacht needs to be at least 18 in. to 24 in. long to sail really well in breezy weather. Racing model yachts are very much bigger, and a lot more expensive.

PROJECT

Work out the cost

Make out your own list of working model sizes, and add costs. You can get this information from catalogues and leaflets at model and toy shops. See how these figures fit into the 'family tree'. They will be a good guide as to what type of model you can best afford.

PART TWO

How you can make a waterline model

A waterline model is a non-working scale model, so first you must decide on a suitable scale to work to. Start by planning a tabletop display realistically representing a large working harbour. Make a list of various ships which would use such a harbour, and their size: liners, 500 ft. to 1,000 ft.; large merchant ships, 500 ft.; coasters, 250 ft.; tugs, 100 ft.; pilot boats, 50 ft.

PROJECT

Visit a big harbour

Study pictures of harbours, or better still visit a big harbour, and make a note of the different types of ships there. Make sketches, too, and note the names of liners and large vessels. You can look up their size later in books in your local library. Make a note of the beam (width) as well. You will see why later.

Now work out a suitable scale for your harbour fleet. The smallest ship is the pilot boat (50 ft.). The largest is a 1,000 ft. liner. Using 1/500th scale this would make the liner 2 ft. long, and the pilot boat about 1 in. long. You would not get many liners that size on a table, so halve the size and go to 1/1,000

scale. That makes the liner 1 ft. long. The pilot cutter is now only ½ in. long, but that does not matter.

PROJECT

Keep the shapes simple

To make a drawing of each model start by measuring the length and then sketching in the hull shape. (*See fig. 1.*) Add the upper decks, bridge and funnel, keeping the shapes as simple as possible, but also realistic.

You can use photos or drawings of full-size ships as a guide, or sketches you have made at the harbour. All you want is the

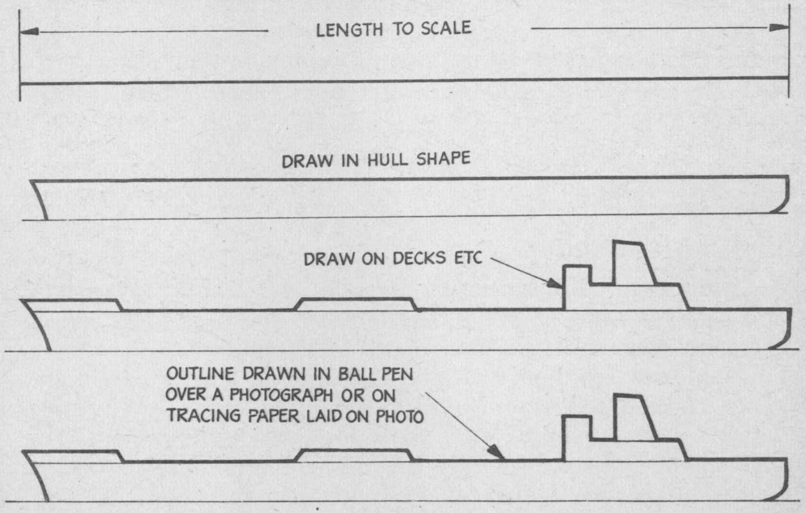


Fig 1

model to *look* right. It does not have to be an exact scale model. (*See fig. 2.*)

Each model is then built up from parts cut from sheet balsa. The hull should be made first. We know the length, and the thickness of the sheet required (from our drawing), but not the width. This we get from our beam measurement we noted above in looking up ship sizes.

PROJECT

Work out the beam size

Work this out to scale and cut a rectangular hull piece to this width. Thus if the beam is 120 ft. on a 1,000 ft. liner, the length

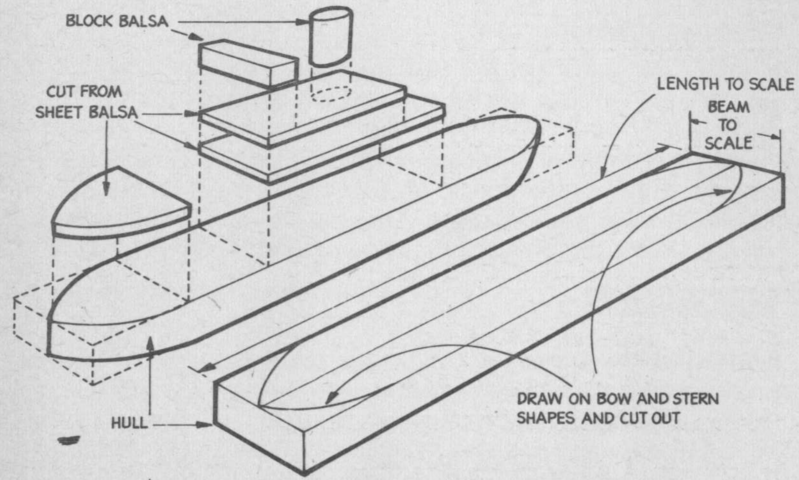


Fig 2

to 1/1,000 scale is 1,000/1,000 = 1 ft. = 12 in. and the beam width to the same scale is:

$$120/1{,}000 = 12/100 \text{ ft.} = \frac{12 \times 12}{100} \text{ in.}$$

or say $1\frac{1}{2}$ in.

A simple rule for beam

If you cannot find what the beam of any ship is, then you can use the following simple rule. Make the beam 1/10th of the length for liners and other large vessels; 1/8th of the length for vessels from 300 to 500 ft. long; 1/5th of the length for vessels from 150 to 250 ft.; a quarter of the length for those under 100 ft.

PROJECT

Shaping the hull

Once you have cut out the hull piece to length and width, only simple carving and sanding is needed to shape the bows and stern.

You will find few photographs showing a top view of a ship, so you will have to guess. Liners have a fine, tapering bow shape. Smaller vessels usually have a blunter bow and work vessels, like a tug, a very blunt bow. (*See fig. 3.*)

PROJECT

Finishing the model

Cutting the remaining parts is quite easy, using $\frac{1}{8}$ in. and $\frac{1}{16}$ in. sheet balsa. The bridge and other similar shapes can be cut from strip balsa. Build up the final shape in layers, cementing each in place with balsa cement. The complete model can then be painted in poster colours, before adding the final details.

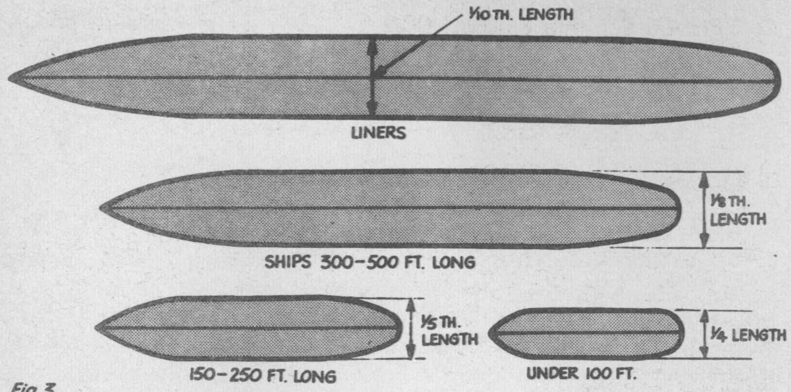


Fig 3

Do not try to add too much detail as this will only make the model look unrealistic. If you think of the full-size ship being so far away that it looks the same size as the model, then the detail you could see of the full-size ship at that distance is right on the model. The smaller the length of the model, the less the amount of detail it wants. It is getting the general appearance right that matters.

PROJECT

Starting a note-book

Record in a note-book all the details you can for making waterline models of various ships to complete your fleet. *Fig. 4* shows what each page should look like—a sketch of the ship with notes on colour and anything special about it—name, type, and so on. Other details you may have to leave blank, such as length and beam, until you can look them up later.

When you visit a harbour also note and sketch docks, position

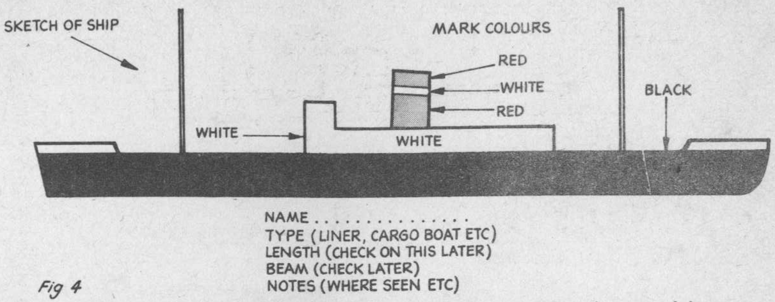


Fig 4

and shape of dockside buildings, how and where ships are moored, and things like that. You can get the same sort of information out of books in a library, but it is more fun seeing it all in real life.

PROJECT

Planning a harbour

Design your own idea of an ideal harbour. To start with plan a harbour using the following models: Liners *QE2*, *United States* and *France*; two large merchant ships; two pilot boats; three tugs; and one ferry. (*See fig. 5.*)

The dockside, harbour buildings and so on are laid out as shown in *fig. 6*, using thick balsa sheet (docks and wharves), blocks of wood (buildings), and so on.

PROJECT

Make the harbour live

To work your harbour you need a timetable for the departure and arrival times of the larger craft. Smaller craft can move about in the harbour, or be moved in and out of the harbour,

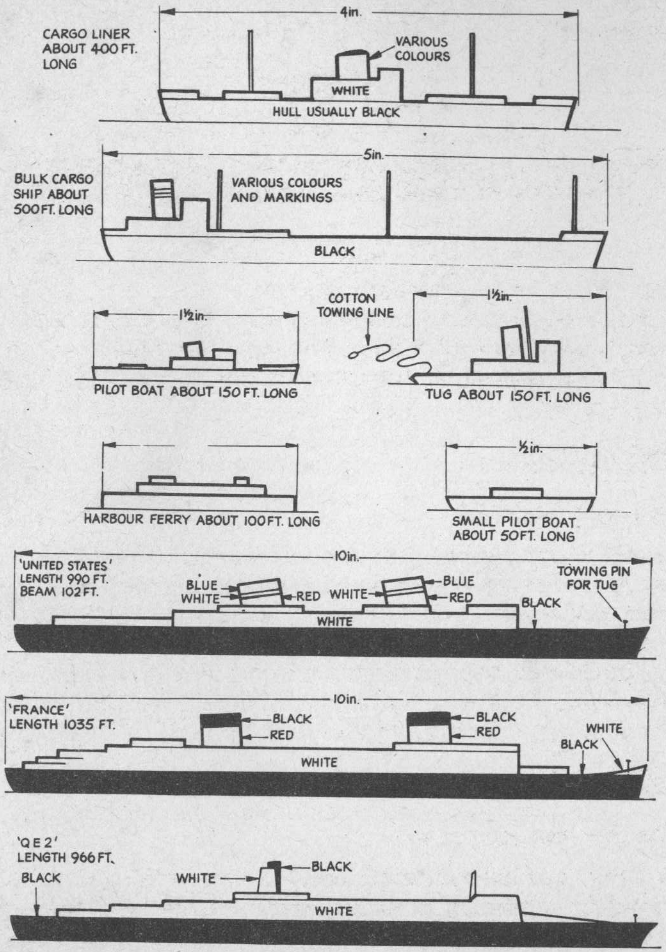
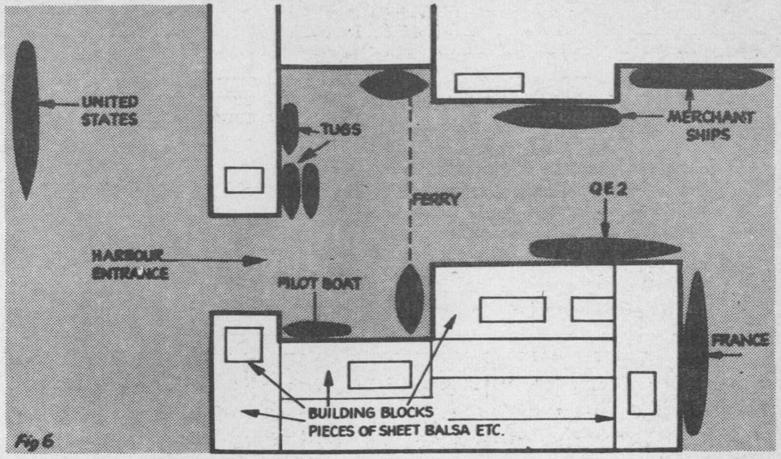


Fig 5



when you are not busy 'handling' the big vessels. This is the start of a timetable:

The *QE2* and *France* are getting ready to leave. The *United States* is outside the harbour, waiting to come in. Meantime, the ferry is operating across the harbour every ten minutes. At 10 o'clock, move the ferry from one side to the other.

The *QE2* is waiting to leave, so bring a pilot boat alongside, and two tugs. A cotton line attached to each tug is made fast on the towing 'pin' on the *QE2*. At 10.5, ease her off with the tugs and tow her towards the harbour mouth. Follow with the pilot boat.

The tugs can cast off when clear of the harbour entrance and the pilot boat can come alongside to take off the pilot. Pilot boat and tugs can then proceed out to the *United States* waiting to be towed in. Back in the harbour the ferry is ready to cross again.

TIMETABLE

Ship	*Depart*	*Arrive*
Ferry	10.00 then every 10 minutes	
QE2	10.05	11.00
United States	—	10.20
France	10.30	—
Cargo Ship (1)	10.10	11.05
Cargo Ship (2)	10.15	11.10

You can see how interesting and realistic working a model harbour like this can be. Also how important it is to plan the timetable properly, otherwise you will have more to do than you can cope with. Get a friend to work the harbour with you so you can handle more traffic.

PROJECTS

Make different harbours

Plan and operate different types of harbours. For each harbour you will need a different set of models (although some models will belong equally well to almost any type of harbour); and different timetables. Some suggestions:

(i) A naval harbour with an aircraft carrier, cruisers, destroyers, patrol vessels, submarines, and so on—with tugs to handle the larger vessels.

(ii) A tanker harbour (note that large tankers usually unload alongside jetties instead of inside harbours, because of their great length).

(iii) Smaller harbours with a mixture of smaller cargo vessels, cross-channel boats, car ferries, and perhaps a hovercraft (no tugs needed here).

In each case, collect all the information you can in your notebook first. Then plan both the harbour layout and the type and number of models you require from this.

Work out for yourself what accessories you can build, to the same scale, such as cranes and warehouses, to make your harbour look more realistic.

PART THREE

How you can build a full-depth model

Full-depth models are usually made for display and are mounted on a base so that they stand upright. Again you should make models of similar types of craft to the same scale, which should be larger than that used for waterline models. This is because the larger the model is, the more detail you can add to it—and a display model needs to be well detailed.

The best example of a display model is that in a plastic kit. This usually has far more detail than you could add to a wooden model of the same size and still look right. The advantages of a wood model are that it is cheaper, although it takes longer to make, and you can make it to any size or scale you like, and of any ship you like. You can even design your own high speed naval boat, modern liner, super hovercraft, or whatever you fancy.

PROJECT

Study drawings first

The method of making full-depth models is similar to that used for waterline models. The main difference is that the hull is deeper and must be carved from a block of balsa, instead of just cut from sheet. It is important to get this hull shape as near correct as possible, so study as many drawings and illustrations

of the full-size craft as you can before you make a start. Sources of such information are reference books or books on ship modelling in your local library; illustrated catalogues of ship models; plastic kits of similar craft you may have built, or have seen in model shops; ship models in museums; plans of scale ship models.

You can forget the last unless you are an experienced modeller. They are expensive and difficult to work from. Most people find near-scale models quite good enough. If you want true scale models, then it is much simpler, and probably cheaper, to work from plastic kits.

PROJECT

Building a galleon

A built-up full depth galleon, made near-scale, is shown in *fig*. 7. Even if it is not very near to scale, it still looks like a galleon. The detail has been kept very simple without spoiling what the model is intended to be. After building one or two simple models like this you can try one which is more detailed, perhaps making it a little larger as well. A good size for simple model galleons is about 8 in. to 10 in. long.

PROJECT

Building a liner

This is a much simpler type of model to make for the shapes of the parts are less fussy. Also you do not have to bother much about rigging. But because the model is simpler it needs to be made more carefully and more accurately if it is to look realistic. Getting the hull proportions right is most important. The most

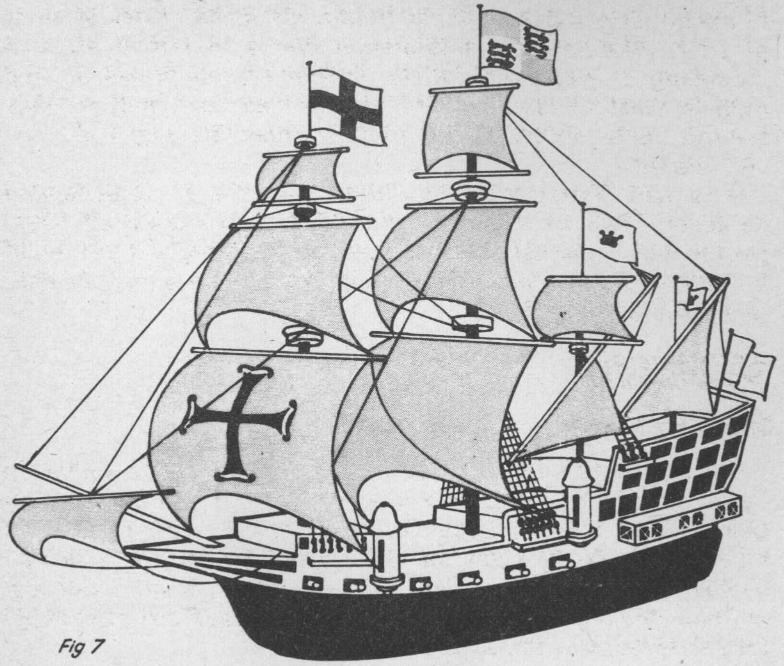


Fig 7

usual mistake is to make the hull too deep, and too wide. It then looks more like a toy than a model liner.

Work out the correct width and depth in proportion to the length of the hull block. If you cannot find the depth anywhere in a reference book, then make it the same as the width. This will not be far wrong.

Carve and sandpaper the hull to a realistic shape and finish really smooth. Decks and superstructure parts are cut from balsa sheet and blocks and cemented in place. Use the same rule given in Part Two for deciding how much detail to add.

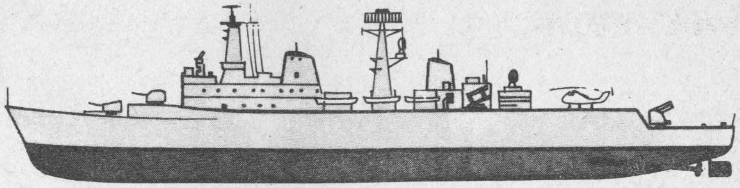


Fig 8

PROJECT

Building a destroyer

A destroyer is shown in *fig. 8*. It is even more important this time to get the hull proportions right as nothing looks more unrealistic than a fat destroyer. We can save a bit of work—and expense—by building up the front part of the hull with a piece of thick sheet balsa cemented in place, otherwise the construction is similar to that of a liner.

PROJECTS

Fleets through the ages

(i) Build a series of different galleon models, all to the same scale. Make notes on the history of each. You will then be able to talk about each one when showing the models to friends.

(ii) Build a series of near-scale models representing ships through the ages—starting with the hollowed out log, Grecian and Roman ships, and so on, up to the present day. These need not all be to the same scale.

(iii) Build a series of models showing the history of liners or warships. Work out further ideas like this.

PART FOUR

How to build the South Sea way

Man's first 'boat' was a log on which he sat astride. Men living in Ecuador, in South America, were lucky. They had balsa trees growing all around them. Balsa is the lightest of woods, so a balsa log floats better than any other log. By lashing balsa logs together in the form of a raft they made seaworthy craft more than three thousand years ago. (Look up the book *Kon Tiki* by Thor Heyerdahl in your local library. It is a fascinating account of a Pacific voyage on such a raft.)

PROJECT

Make a Kon Tiki raft

Buy two 36 in. lengths of 1 in. diameter balsa dowel, and a 36 in. length of $\frac{1}{2}$ in. × $\frac{1}{4}$ in. balsa strip from your local model shop. (If you cannot get 1 in. dowel, buy $\frac{3}{4}$ in. square balsa strip and round off the edges to a 'log' shape.)

Cut the dowel into 1 ft. lengths and cement these together in the shape of a raft. (*See fig. 9.*) Add the $\frac{1}{2}$ in. × $\frac{1}{4}$ in. cross pieces to strengthen, and a 10 in. length of garden cane for a mast. Cut a sail from stiff paper and fit as shown. You can make up a 'box' from balsa sheet to act as a shelter, and add a rudder, as shown

in the diagram, to make a model of the original Kon Tiki raft.

You will find that this raft will sail well on any pond or stretch of open water. It will sail only downwind, of course, but it will never sink, or turn over, even if it is rough. Like the ancient Kon Tiki raft, it is very seaworthy.

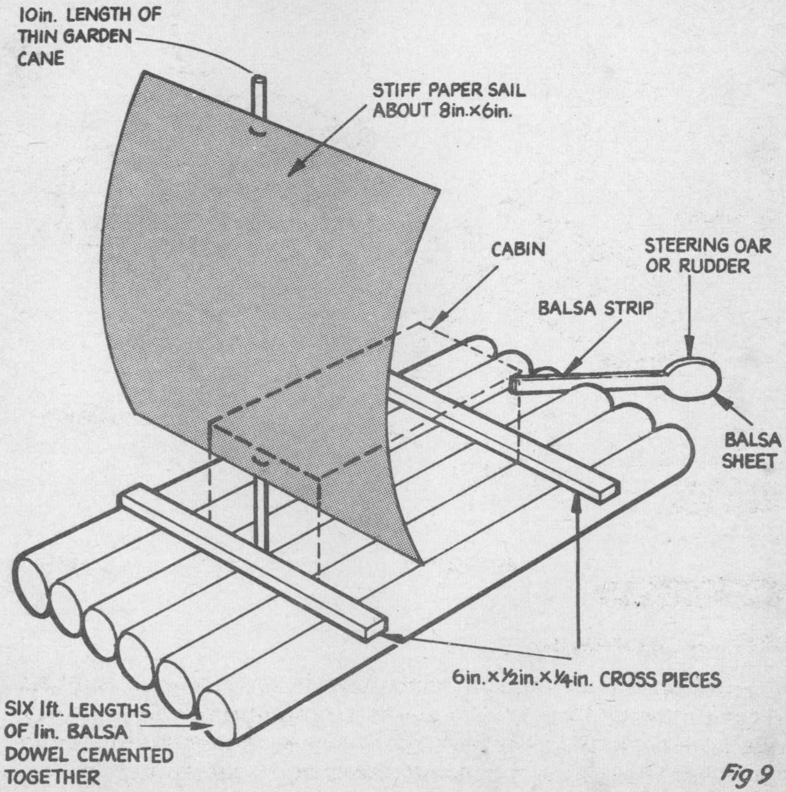


Fig 9

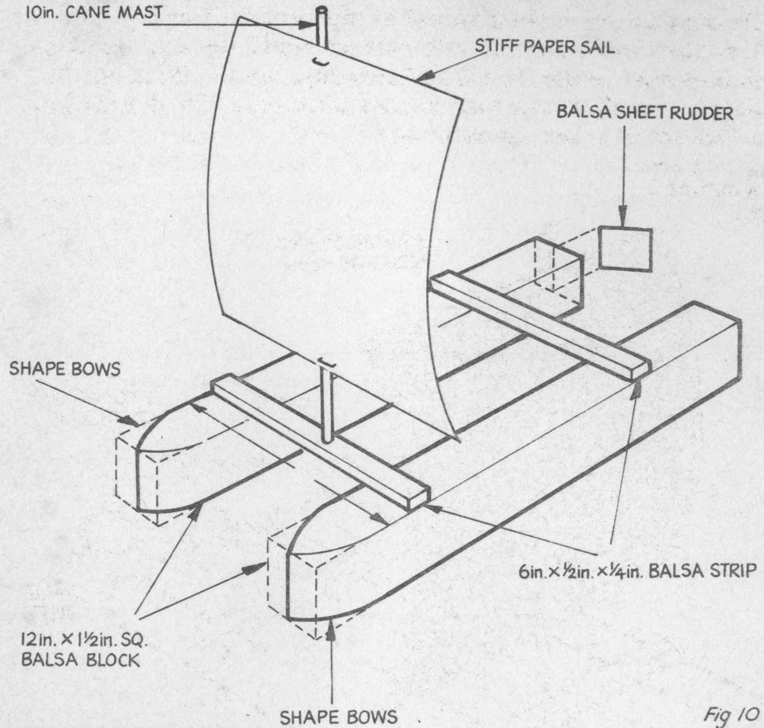


Fig 10

PROJECT

Make a catamaran

Although a raft may be unsinkable it is very slow since it has to push its way through the water. On the other hand, it owes much of its safety to the fact that it is very wide and difficult to tip over. Over two thousand years ago, somebody in the

Southern Seas had the bright idea of combining a slender shape which cuts its way through the water with the width of a raft by joining two shaped logs together with long struts. That was the first catamaran.

Fig. 10 shows how to make a simple model catamaran, shaping the two hulls from $1\frac{1}{2}$ in. square balsa. Fit the same size mast and sail as the Kon Tiki raft. It will be faster and sail more broadside to the wind, if the sail is fastened at an angle. If the weather is breezy you will also discover that although the

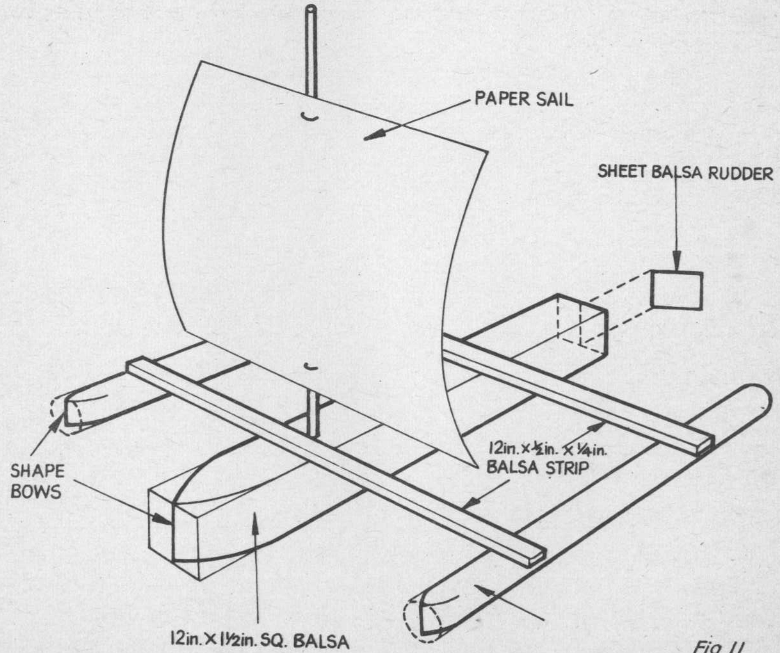


Fig 11

catamaran is faster it is not as safe as the raft. It can get tipped over in a gust.

PROJECT

Make a trimaran

To avoid being tipped over the trimaran was developed. This uses a long, slender central hull with two smaller hulls or out-rigged floats mounted on cross braces. *Fig. 11* shows the construction of a model trimaran using similar parts to the two previous models.

PART FIVE

Making boats with hollowed hulls

You may have noticed in the catamaran and trimaran models that, although balsa is very light, by the time mast and sail has been added the model floats low in the water. If we have just a single hull we have another difficulty. Let us carve one and see.

Fig. 12 shows a modern hull shape carved from a 1 ft. length

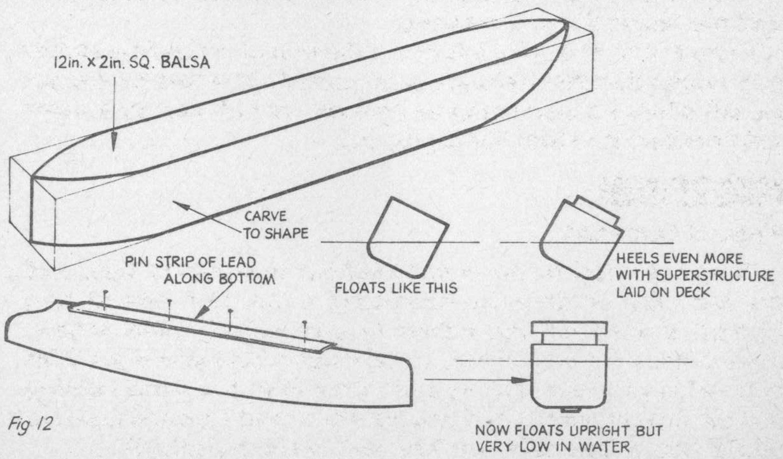


Fig 12

of 2 in. square balsa, in just the same way as we made a full-depth hull in Part Three. It will not float upright, but will lay over, or heel, to one side. If we cut the superstructure pieces and just lay them on top of the hull, it will heel even more, and the hull will sink lower in the water.

PROJECT

Make it steady

Can you see how to make such a hull float properly? The hull needs ballast or keel weight. If you study science you should be able to work this out (the centre of weight must be below centre of buoyancy). The answer is quite simple. You must add weight to the bottom of the hull until it floats level. A strip of lead about $\frac{1}{2}$ in. wide makes a good ballast weight. You can cut this from sheet lead with scissors. Pin one strip to the bottom of the hull and see if this does the trick. If not, add another strip until the hull is floating properly.

There is just one snag left now. The model is floating so low in the water that the decks are nearly awash. It seems we cannot use solid balsa construction as an easy way of making a near-scale or scale hull that floats properly.

PROJECT

Make it buoyant

What we need to do now is lighten the shaped hull, and this can only be done by hollowing it out. Use one or two different shaped carving blades in a modelling knife handle. These blades are very sharp, so be careful how you work with them. Always make carving cuts *away* from the hand holding the hull, never towards it. If you have not used a modelling knife before, you will be safer working with a sharp penknife.

Steps in hollowing out the hull are shown in *fig. 13*. Mark a pencil line about $\frac{1}{4}$ in. inside the top of the hull as a guide and start by taking out V-shaped cuts from the centre. Cut out as much wood as you can without getting too near the sides.

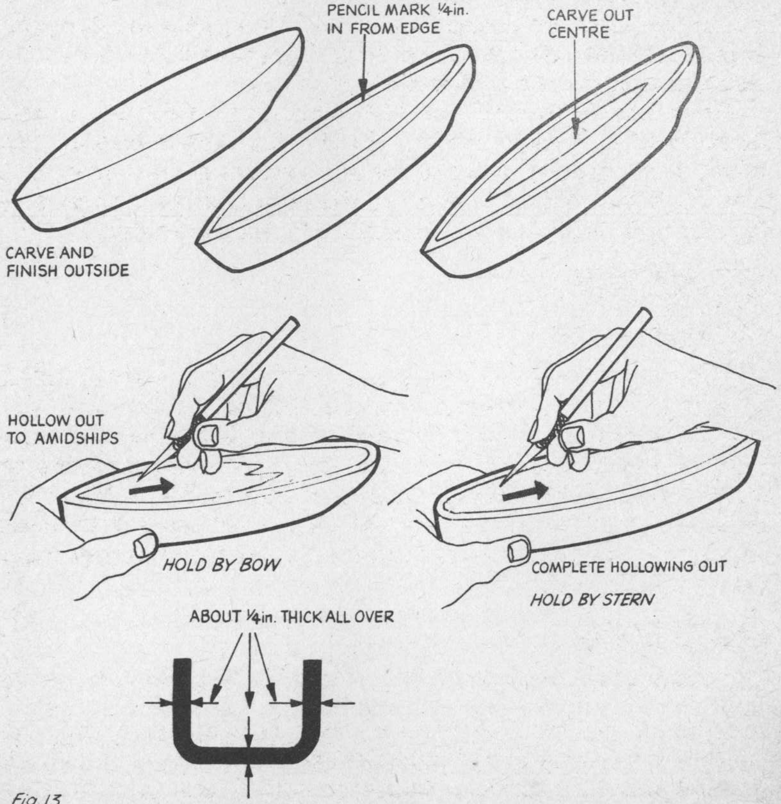


Fig 13

Now hold the hull by the bow and carve from the bow to midships out to the pencil line, and as deep as you can without cutting through the sides and bottom. Turn the hull round, hold by the stern and carve out to the pencil line from the stern to midships. Work slowly and carefully. The nearer you get to the pencil line, and the deeper you carve, the smaller the cuts you should make at a time. You should end up with the hull hollowed out to a wall thickness of about $\frac{1}{4}$ in. all over.

Finish the hollowing out with glasspaper. First use coarse glasspaper to smooth off the rough cuts. You can then use medium glasspaper to work the walls down even thinner, but not too thin. Hold the hull up to the light from time to time. If light shows through you are getting the walls *too* thin.

PROJECT

Fitting the deck

The hull then needs a deck cut to fit from thin sheet balsa. After that the superstructure can be added, just as with the models in Part Three, and finally the necessary amount of keel weight to make the hull float level. However, if we are going to make a powered model we must also fit a motor. This is described in Part Seven and Part Nine so do not cement the deck to the hull until you have decided what type of motor you are going to use.

PROJECT

Learn how to 'cheat'

A powered model with an electric motor has to carry the weight of the motor and batteries for the motor. This can be difficult with long, narrow hull shapes like those of liners and

destroyers. To make a successful working model of such a type, therefore, we may have to 'cheat' a little—make the hull wider, and deeper, than true scale proportions. As a rough rule the beam wants to be at least a seventh of the length on a working model, and would be better if it is nearer a fifth.

From your note-book you will find the wider beamed ships make the best working models. Leave the trickier, narrower hulls for later projects when you have some experience of making and operating working models.

PART SIX

The way to build up a hull

Hollowed-out hulls are all right for smaller models but when it comes to a bigger job the cost of a solid block of balsa the right size can be off-putting. And most of the balsa we have paid for is cut away.

There is a cheaper, and much simpler, way of building up a hollow hull, particularly if we are making a near-scale rather than a true scale model. You can see how to do this in *fig. 14*.

PROJECT

Work out the size

Start by marking out the shape of the hull on a piece of thick sheet balsa. For models up to about 15 in. long, use $\frac{3}{8}$ in. sheet. For larger models, use $\frac{1}{2}$ in. sheet. Remember that the beam should be at least a seventh of the length. That sets a limit for the length of hull should not be more than 7 in. × 3 in. = 21 in. Using 4 in. wide sheet, the length of the hull should not be more than 7 in. × 4 in. = 28 in. For a larger model you will have to join two pieces of sheet balsa for the bottom.

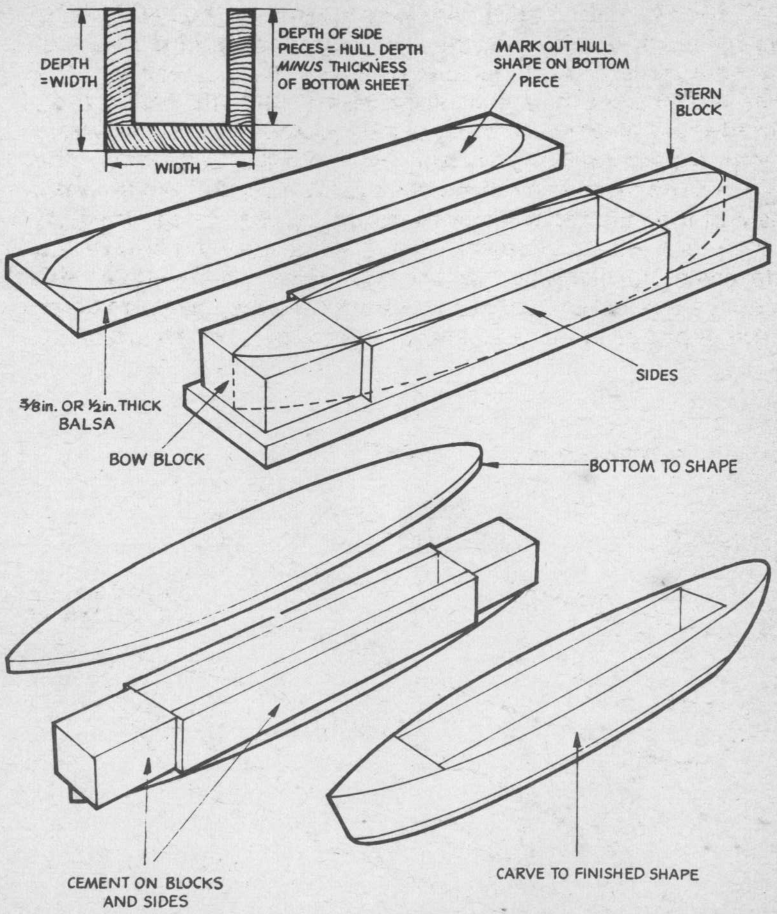


Fig 14

The depth of the hull should be the same as the width. After you have worked this out, the rest is quite straightforward. Cut two side pieces from the same thickness sheet as used for the bottom, and a bow and stern block. The depth of the side pieces, and the two blocks is worked out by subtracting the thickness of the bottom piece ($\frac{3}{8}$ in. or $\frac{1}{2}$ in.) from the hull depth. The width of the bow and stern blocks can be a little less than the beam of the hull, for these come on the curved parts of the hull.

Now cut out the bottom piece to shape. Lay the blocks and side pieces in place and check that they fit the outline with plenty of overlap on the inside. When satisfied, cement blocks and side pieces in place and leave to set for several hours.

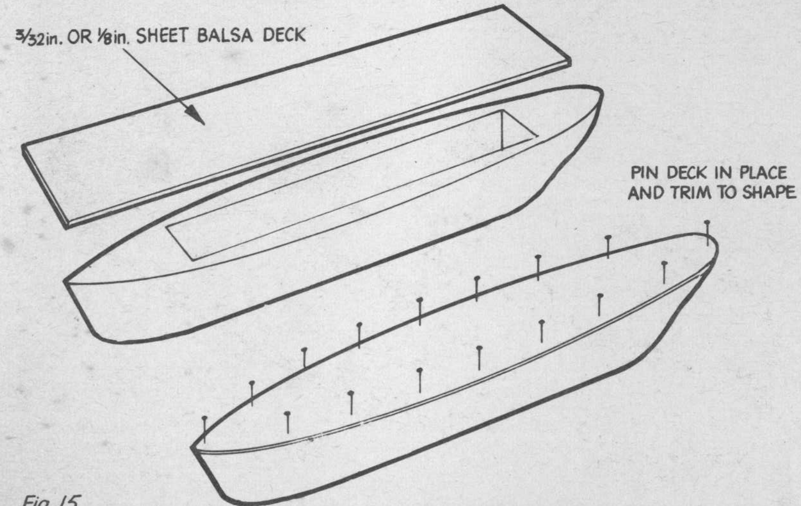


Fig 15

PROJECT

Choose the type of ship

All that you then have to do is carve and sandpaper the outside of the hull down to finished shape. The inside is already hollowed out. Make sure that you do not carve away too much wood where the sides join the blocks, especially when rounding off the bottom. If you accidentally make a hole here, cement a small block of balsa on the inside.

The hull is completed in the usual way with a deck, followed by the superstructure. The deck can be cut from $\frac{3}{32}$ in. or $\frac{1}{8}$ in. sheet balsa. Pin a panel in place and trim to shape. (*See fig. 15.*)

Fig. 16 shows three different types of superstructure you can fit to the same hull. Use the lightest balsa you can get for all the superstructure parts. The more you can reduce the weight of the superstructure, the less ballast weight you will need. If you want to fit a fairly tall superstructure (model liner) it is best to build this up in the form of a box from balsa sheet, rather than use a solid block of wood.

PROJECT

Build up a fleet

From books on ships, or a visit to a harbour, make sketches of suitable superstructures. You can enter these in a 'Design' note-book, plus notes on colours.

Then you can mass produce hulls for your model fleet, and complete individual models with different superstructures. If they are to be floating or working models, any colouring must be done with model aircraft dopes which are waterproof.

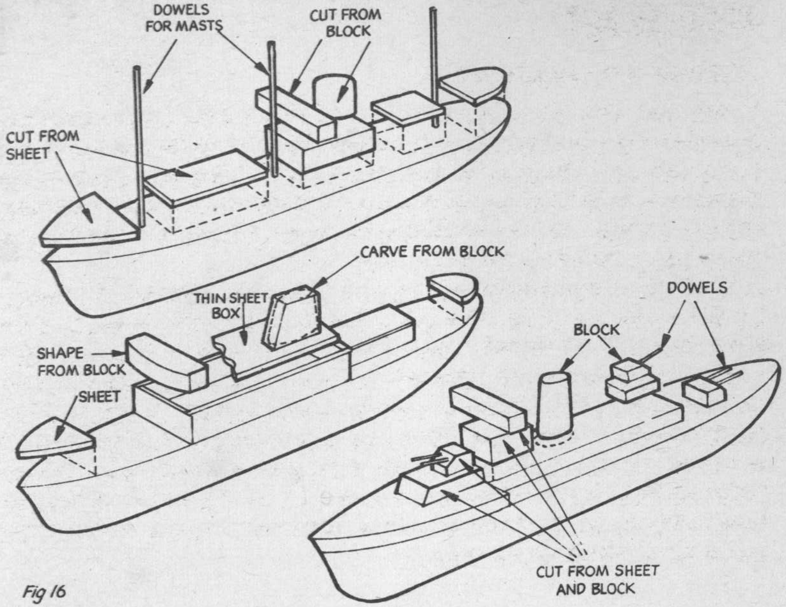


Fig 16

PART SEVEN

Models with rubber motor power

A long rubber band or a loop of model aircraft rubber strip is the simplest—and cheapest—form of motor for a powered model. This can be fitted underneath a hollowed-out or built-up hull. (*See fig. 17.*) The tricky part is the propeller assembly.

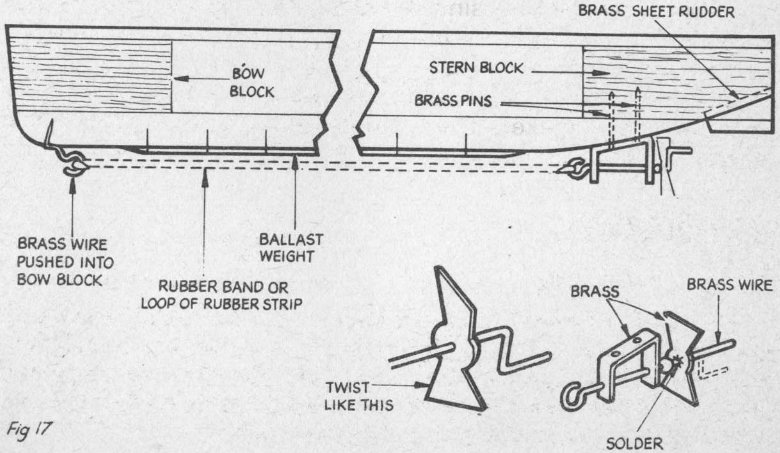


Fig 17

PROJECT

Making the propeller

The propeller should be about 1 in. diameter. It is cut from tinplate or thin brass to the shape shown, using scissors. A strip of brass is also cut from sheet about $1\frac{1}{2}$ in. long and $\frac{1}{4}$ in. wide. This is bent into a U-shape to form a bearing. Holes are pierced or drilled in this, and the centre of the propeller, to take the propeller shaft, which is brass wire. Two more holes should be pierced in the top of the bearing so that it can be pinned in place to the bottom of the hull.

The propeller shaft is bent to the shape shown. Bend the hook end first, pass through the bearing, slip on a small bead, and then bend the crank end. The propeller is then slipped in place over this cranked end and finally fixed by soldering to the shaft. If you are not good at soldering, then you can stick the propeller to the wire using Araldite. As well as pinning the propeller assembly to the bottom of the hull, this too, should also be stuck with Araldite.

Note: Araldite is an 'epoxy' glue, sold as a two tube pack. There are other makes which are as good. 'Epoxy' glues stick almost anything permanently.

PROJECT

Fixing the motor

The rubber motor is slung between the propeller shaft and another wire hook pushed into the bows. Bend the propeller blades to a propeller shape—that is, twist them in opposite directions. The cranked end of the shaft is for winding up the motor. You will have to find by experiment:

(i) Which way to wind the motor to propel the model forwards (depending on the way you have twisted the blades).

(ii) The right amount of twist to get the best performance from the rubber motor.

These tests are best made in a bath, just letting the model run the length of the bath and then making adjustments to propeller twist. You can also try what difference it makes when you use a thicker or thinner rubber band (or rubber strip); or use two or three bands instead of one.

PROJECT

Organise 'sea' trials

Before being 'ready for sea' your model will, of course, need ballast to make it float level with the superstructure in place. You can use bath trials to get the ballast weight right. You will also find that you have to fit a rudder to get the model to run straight. This can be cut from thin brass or tinplate and simply pushed into a slit made in the stern block.

Another way of fitting a rubber motor is shown in *fig. 18*. This time the motor is enclosed in a narrow 'box' built up from balsa sheet cemented to the bottom of the hull. Front and rear fittings for the rubber motor are slightly different, as shown.

PROJECTS

Can you work out how many advantages this method has, provided the front and rear end plugs are watertight? Part Five will give you two answers. Are there any more?

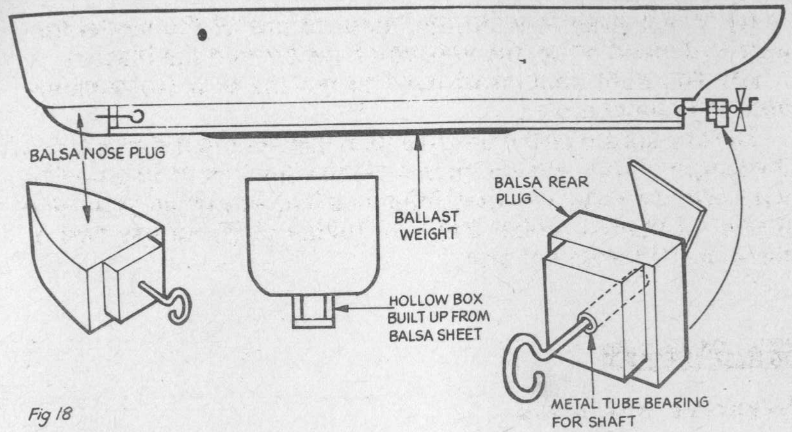


Fig 18

PART EIGHT

How to make a submarine

A working model submarine is easy to make. The hull can be carved from solid balsa block, and the conning tower, or wing as it is called on modern submarines, from thick balsa sheet or a smaller block. The hull does not have to be hollow for the model needs 'trimming' to float level with the deck awash.

PROJECT

Carving the hull

From a 2 in. square block of balsa you can make a model submarine hull about 15 in. to 18 in. long. The bows need carving to a pointed shape, but you can leave the deck and bottom fairly flat, rounding off the edges at the bottom. The stern also needs a bit of shaping.

A rubber motor can be fitted underneath the hull, as described in Part Seven. The rudder needs to be fairly large, and fitted right at the stern. *Fig. 19* shows what the complete model should look like.

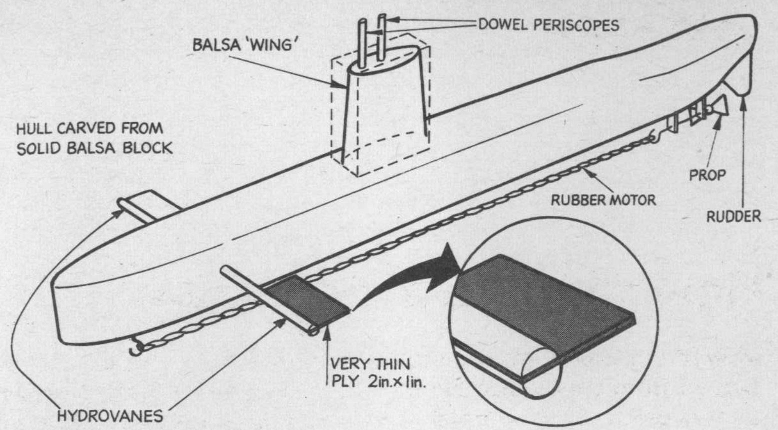


Fig 19

PROJECT

Fixing the hydrovanes

An important extra fitting is the hydrovanes. These are two 2 in. × 1 in. panels cut from very thin plywood (or you could use sheet brass), glued into a slit cut in each end of a length of hardwood dowel (use Araldite if you have made the vanes from brass). The hydrovanes are assembled in this way:

(i) Cut the two vanes; also cut the dowel to length and slit the ends carefully.

(ii) Drill a hole through the hull of the submarine 3 in. or 4 in. back from the bow, using a drill which is slightly smaller than the diameter of the dowel.

(iii) Force the dowel into this hole, with an equal amount projecting each side.

(iv) Glue the vanes into the slits in each end of the dowel, but be careful not to glue the dowel to the hull. When dry, you can twist the dowel to turn the vanes to different angles.

PROJECT

Trimming your submarine

After the model has been completed—and painted—see how it floats in a bath. Add ballast weight to the bottom, pinning in place, until the model floats level fore and aft, with the deck just awash. (*See fig. 20.*) Twist the hydrovanes so that they are horizontal, that is parallel to the surface of the water. Then carry out 'power trials' to adjust the twist of the propeller, as described in Part Seven. The model is then ready for pond tests.

You must choose a pond which is free from weed, otherwise the model may be snagged during a dive and never surface again. Twist the hydrovanes so that they are set with an upward tilt of about 10 degrees, wind about one hundred turns on the rubber motor, put the model in the water and let it go.

As it travels forward the hydrovanes will push the bow down. If you have got the trim right the model will dive and continue to run under the water until the power starts to run out, when it will rise to the surface again.

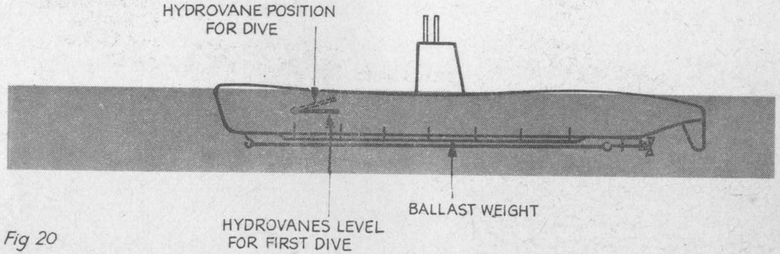


Fig 20

PROJECT

Diving trials

Experiment until you get the best results with:
(i) the setting of the hydrovanes
(ii) the size of the rubber motor
(iii) the twist of the propeller.
Your model submarine is then properly 'in trim'.
If you cannot get a good diving trim:

(i) Try increasing the amount of ballast if the model will not dive properly.

(ii) Try cutting down the size of the vanes, or decreasing the size of the rubber motor, if the model dives too steeply.

PROJECT

Saving your submarine

'Subsmash!' is the emergency signal given when a submarine dives but fails to surface again when expected. It could happen

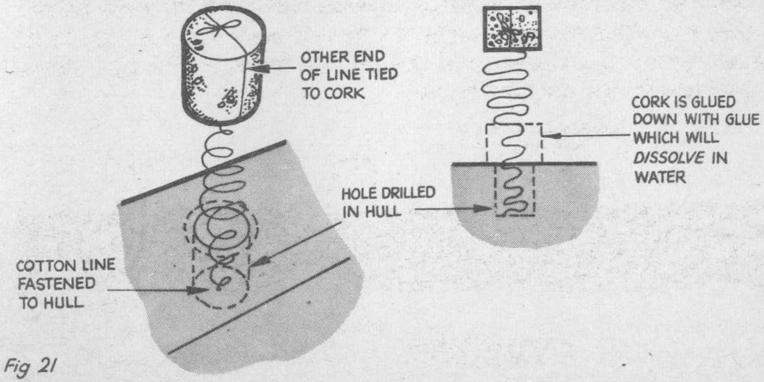


Fig 21

to your model submarine. You can fit a *subsmash buoy* to your model to locate it and help retrieve it, should this emergency occur. This is how it is done.

Use a cork for the buoy and to this tie a length of thin thread or cotton which is at least twice as long as the maximum depth of water in the pond. Bore a hole in the deck of the submarine into which this line can be neatly coiled with the free end pinned to the hull. Stick the cork over the hole with ordinary gum. (*See fig. 21.*)

Now if the model stays submerged too long the gum will dissolve, releasing the cork which will float to the surface. Cork and submarine are attached by the line—so if you can reach the cork you can draw the model up to the surface and rescue it.

PART NINE

How to give your boat electric power

A small electric motor is the best type of power unit for most working models. A suitable motor can cost as little as 15p or 20p when the only other items required are:

(i) A propeller assembly (comprising stern tube, propeller shaft and propeller). You should buy a propeller assembly with a shaft diameter the same as that of the motor.

(ii) A short length of plastic tube to fit the motor shaft.

(iii) Suitable batteries for the motor.

(iv) Some thin insulated wire for the electrical connections.

PROJECT

Fitting the motor

The method of fitting out a hull with an electric motor drive is shown in *fig. 22*. The propeller assembly is pushed through an angled hole drilled in the bottom of the hull and well cemented in place to hold secure, and also prevent leaks. Keep the angle fairly shallow—just enough for the propeller to have clearance to rotate.

The electric motor is then mounted on a block of balsa, suitably shaped, so that it *lines up exactly* with the propeller

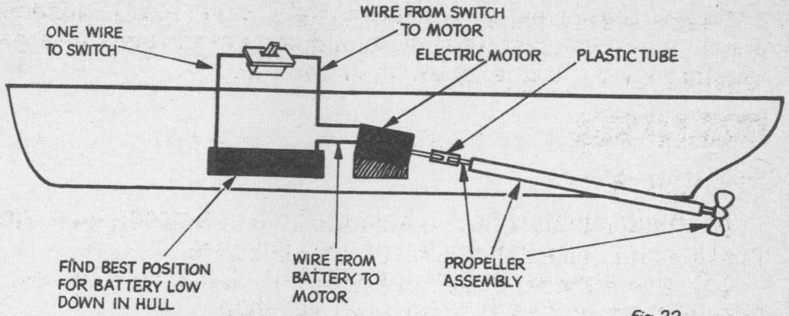


Fig 22

shaft, this shaft and the motor shaft almost touching. The two shafts are connected by slipping a length of plastic tubing over them. That is all apart from the electrical connections.

PROJECT

Fitting the batteries

To find the best position for the batteries you should float the hull with the motor and propeller assembly already fitted. Lay the batteries in the hull and move about until you get the best trim. You may, or may not, need ballast weight as well on the bottom of the hull to get the hull to float level without heel.

Once you have found the best position for the batteries, build up a little box from balsa sheet to hold them in place. You can then complete the wiring, that is:

One lead from one side of the battery to the motor.

One lead from the other side of the battery to a switch mounted on deck.

One lead from the other side of the switch to the other side of the electric motor.

You can easily make a suitable switch, or buy one. Instead of a switch you can just twist the bared ends of the switch wires together for 'on' and separate them for 'off'.

PROJECTS

Try other ideas

(i) Build a battery box to hold the batteries, which then clip in place and make connection at the same time.

(ii) Use a proper coupling instead of plastic tube for connecting the motor shaft to the propeller shaft.

(iii) Twin motor installations are just as easy, provided the hull is big enough to carry the weight of the motors and batteries.

You will see why the deck and superstructure is never permanently fitted to a powered model before it is finally fitted out. You have to work inside the hull to install the motor and propeller assembly. *Then* you can cement the deck on.

Remember, though, you still have to get inside the hull to change the batteries. This means that you must cut a hatch in the deck, or make part of the superstructure removable.

PART TEN

Building a boat with a hard chine hull

A hard chine hull has square sides and bottom, with a sharp edge where they join. This is the shape most commonly seen on speedboats and motor cruisers. It is also an ideal form of construction for larger hulls since it uses much less material than a hollowed-out or built-up hull.

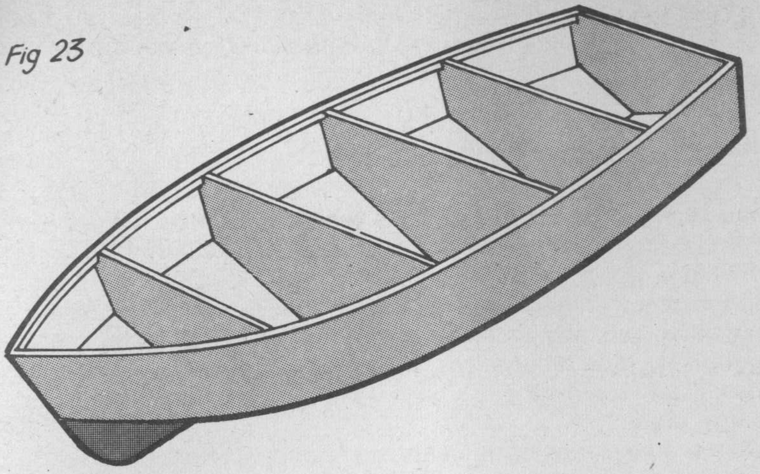
You will notice, too, that the *proportions* of a hard chine hull are quite different. The beam is very much greater for the same length, and usually about one-third of the length. This, together with the flat bottom, means that a hard chine hull will float level, without heeling, *without* the addition of ballast.

PROJECT

Start with a kit

Fig. 23 shows typical hard chine construction. For a start, it is best to build such a hull from a kit, rather than try to design one yourself. The kit will have step-by-step instructions, so you should not have any trouble in building. Also a number of the parts will be pre-cut to shape, which will make the job a lot easier. After you have built two or three hard chine models from kits, then try your hand at your own design—not before.

Fig 23



PROJECT

Now use balsa

Hard chine models up to about 18 in. long are usually built in balsa, with balsa skin panels. Larger models have thin plywood skins, and the frame members may also be ply with thinner strips of hardwood running between them. All-balsa boats are electric motor powered, but ply boats may have electric motors or diesel engines. If you want a fast boat, you *must* use a diesel engine.

Electric motors are not powerful enough for fast boats (unless of very special type, using very expensive batteries). The installation of a diesel is similar to that of an electric motor, with the engine shaft lined up with the propeller shaft, but all the mounting has to be that much stronger. The diesel must

also be water cooled, which means additional piping. (*See fig. 24.*) These details are given on the plan of a kit boat.

PROJECT

For your note-book

You now have another subject for your note-book. Hulls are either hard chine, or *round bilge* (those described in previous parts). Collect notes on which full-size craft are hard chine and which are round bilge.

Most hard chine boats are fast boats. Being flat bottomed they skim over the water or plane, rather than cut their way through it. That means less water resistance, so they can go faster. Can you work out why a wide beam helps a hard chine boat to plane?

What other types of hull can you spot apart from round bilge and hard chine? (Look at pictures of offshore powerboat racers, for example.)

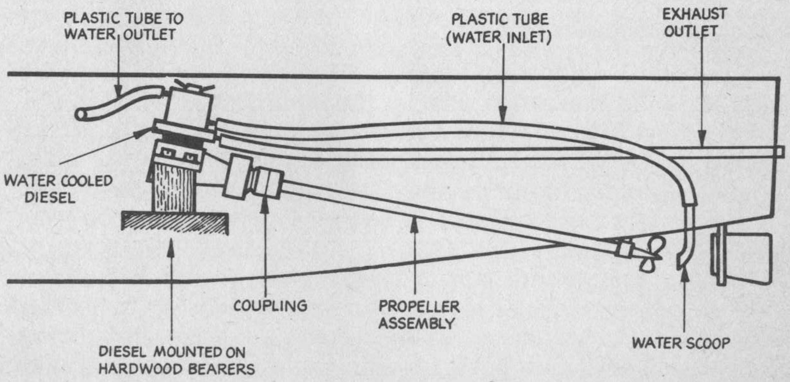


Fig 24

PROJECT

More models to build

Just as we did with built-up hulls in Part Six, we can fit out a hard chine hull with different superstructures. Here are some examples of different models you can make, based on the same hull design: open speedboat; fast day cruiser; offshore power-boat racers; two-cabin cruiser; air-sea rescue launch; fast patrol boat; pilot boat; police launch.

How many more can you add to this list?

PART ELEVEN

The tricks that go with sail

A model yacht is restricted as to the shape of the hull, and the way it can be rigged or fitted out if it is to sail properly.

The hull shape is usually more curved than a power boat. The side view of the hull is more curved, too, but the smaller the length the more straight 'up and down' the bow and stern lines usually are. This is to get a maximum waterline length. The longer the waterline length, usually, the more sail the yacht can carry and the better it will perform.

Since yachts carry a fairly tall mast and sails, the ballast weight is fitted at the bottom of a keel extending from the bottom of the hull. You could not fit enough ballast directly to the bottom of the hull to make a model yacht stable enough under sail, although you can get away with this on some full-size yachts. All model yachts, therefore, must have what is called *deep keel* type hulls.

For the same reason, if you make a scale model of a sailing ship which is not a deep keel type, it will not sail properly. It will lie over on its side in even a light breeze. The only way to make such a model sail is to *fit* it with a deep keel with ballast weight at the bottom.

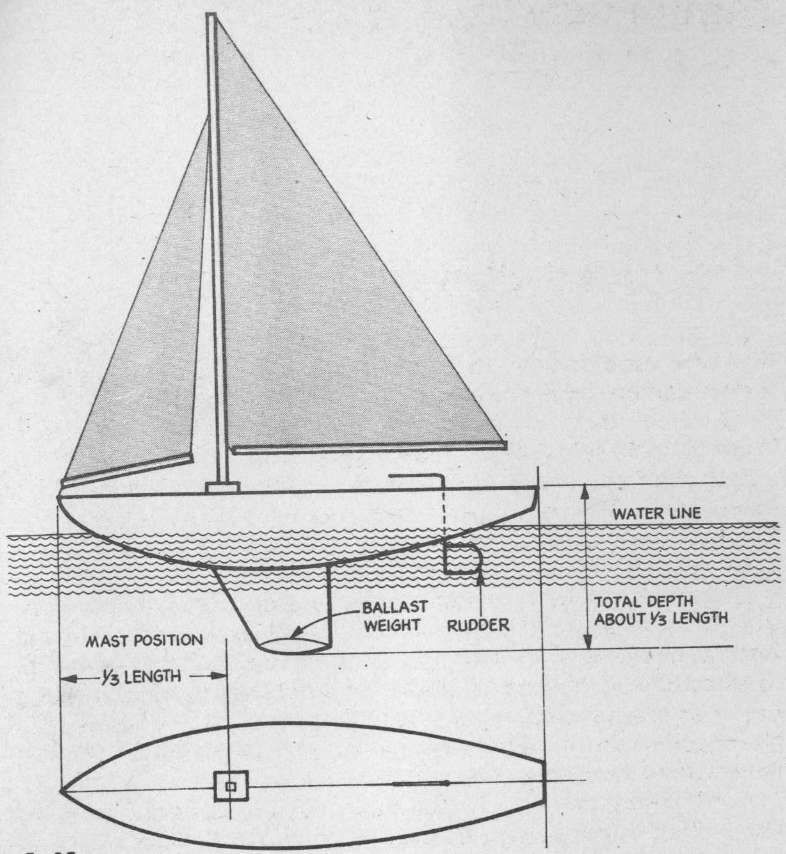


Fig 25

PROJECT

Start modestly

Suitable proportions for a model yacht are shown in *fig. 25*. These hold good for models from about 18 in. long up to 36 in. Larger models usually have slimmer lines and a smaller water-line length in proportion to their overall length. They are nearly always built to Class rules, to designs produced by model yacht experts. You have to be a very experienced modeller to build them, and they are very costly to make. For a starter, a model yacht of about 24 in. length is about the best.

Model yacht hulls are usually of *round bilge* type. They *can* be made by shaping and hollowing out of solid block balsa—but that is an expensive method and not very satisfactory. The built-up method (See Part Six) is better, but will require a 1 in. thick block at least for the bottom and sides.

PROJECT

Plank by plank

The other method you can use is bread-and-butter construction, shown in *fig. 26*. Here the hull is made up from a series of flat 'planks', glued together. Each plank is cut to approximate shape, and all but the bottom one or two planks are also cut out in the centre (wood cut out from the top one or two planks will make the bottom two planks). The whole series of shaped planks are then glued up together, ready for finishing by carving. The amount of carving required is fairly small—just blending the planks together into a smooth curve on the outside, and smoothing off the inside.

Balsa is quite satisfactory for the planks in a bread-and-butter hull up to 24 in. in length. It is very easy to carve and, being a

very light wood, the walls can be left fairly thick. This will ensure that they are strong enough. For a larger hull you would need to use a stronger wood for the planks, such as obechi.

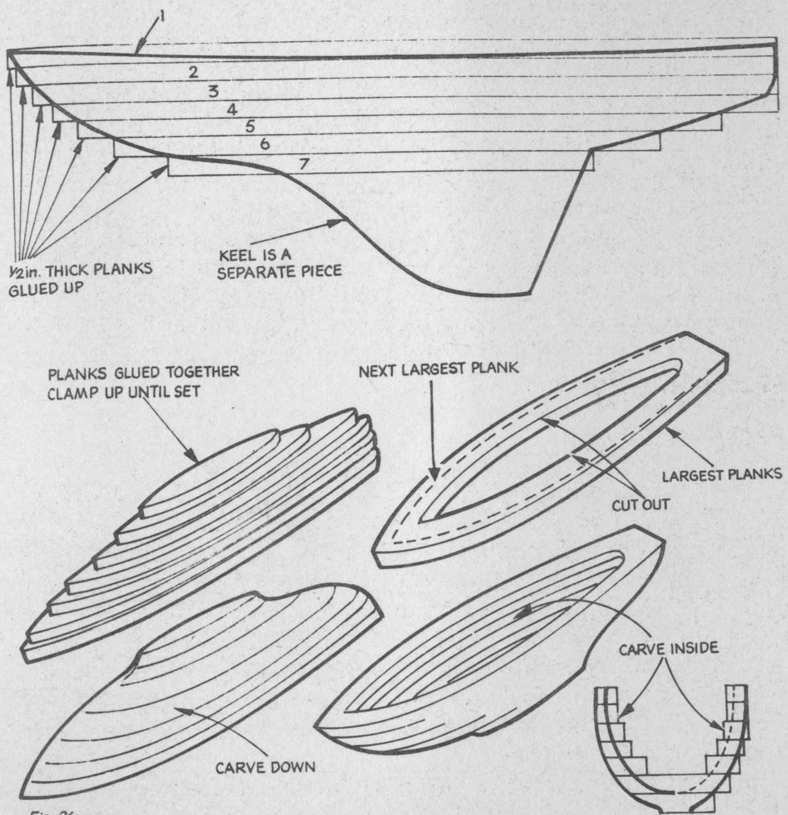


Fig 26

Carving will then be much harder, and you will have to use a plane and gouges, as well as a knife.

The vertical keel piece, which fastens to the bottom of the hull, must always be made in strong wood—such as marine ply. This should be slotted and well glued into the hull bottom, making sure that there are no leaks. Another important thing is to get the keel lined up dead straight with the hull.

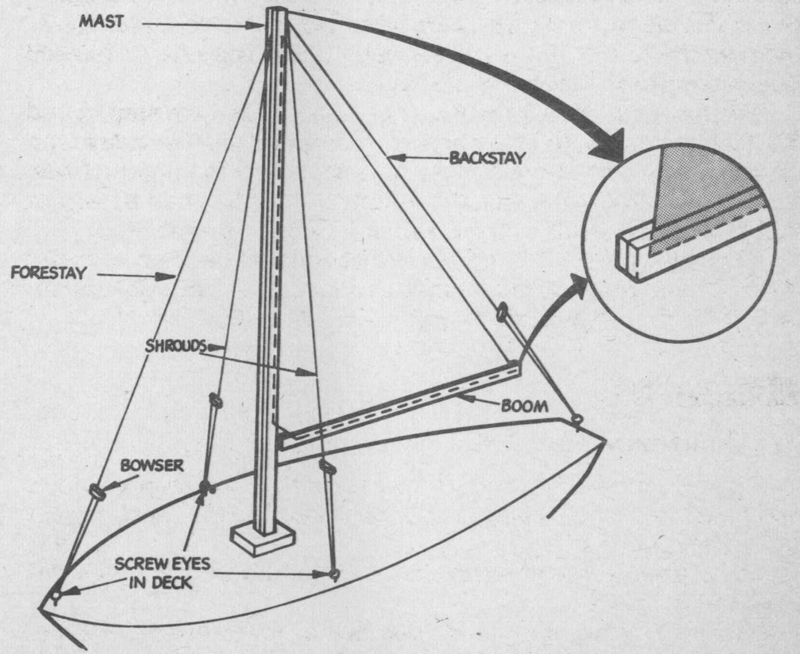


Fig 27

PROJECT

Cut your own sails

Sails can be cut from *polythene sheet*, although *glazed* terylene is better, if you can get it. Cut them carefully to the required shape with scissors. They will not need hemming in either of these materials.

Masts and spars should be of *hardwood strip*. A simple way of fitting the sails is shown in *fig. 27*. The mast and main boom are each made from two pieces of strip, glued together sandwiching the edge of the sail between them. The smaller foresail has just the boom fitted in this way.

The mast can then fit into a small block called the step, glued to the deck and held in position by a *forestay* and *backstay*, and two *shrouds*, as shown. Use terylene thread for the rigging lines, fitted with *bowsies* so that the length of each line can be adjusted to hold the mast upright, and tightly down in the step.

You will find that a *rudder* is essential on a model yacht, otherwise it will not sail straight. This can be a bought *rudder assembly*, fitted through the stern end of the hull.

PROJECT

Go yacht-spotting

Discover other building tips for yourself by examining various model yachts—in toy shops or at your local pond. Check on the following points:

(i) Make notes—and sketches—of the different ways model yachts are rigged.

(ii) Note what special *fittings* are used on model yachts. These can be bought from any model shop.

(iii) Examine a model yacht with an automatic rudder control. Make a note—and sketches again—of how it works. An automatic rudder will improve your model's performance.

(iv) Ask model yachtsmen questions about how they trim their models, how they set the sails, and so on. They will usually be only too pleased to talk about their favourite model.

PART TWELVE

Make your own designs

Remember the 'family tree' we started with in Part One? By now you can probably add a lot more branches to it—round-bilge and hard-chine hull shapes, for example are other sub-divisions. These can apply to sailing boats as well as power boats. (Hard-chine yachts are sometimes called 'sharpies'.)

There are also a lot more types we have not even mentioned. You may see them on a pond used by model boat enthusiasts. For example, there is the airscrew-driven speedboat. This may be rubber driven (with the motor above the hull driving a model aeroplane propeller); or powered by a small diesel or glow motor and a model aeroplane propeller. The hull may be a hard chine type (speedboat), catamaran, or trimaran—or some special racing shape.

Such 'different' models are not difficult to design and make yourself. You have learnt how to make hulls. It is only a case of making them a different shape and fitting them out differently. Here are some other things you can do:

PROJECTS

Get into a club

(i) Join a model boat club. There are usually separate clubs for power boats and yachts. A powerboat club usually offers more scope for the younger enthusiast.

(ii) Start a model boat club among your friends, or at school. There is nothing like getting together with other enthusiasts to get the best out of your hobby. You can exchange ideas and information, organise and run contests, and so on.

Note for younger modellers: The science master at your school, or the local model shop owner are good people to approach for help in getting your club started and organised.

(iii) After you have gained some experience in building and operating model boats, plan to fit your next model with *radio control*. The equipment will be fairly expensive, but perhaps you could ask for it as a Christmas or birthday present.

FOR FURTHER READING

Boat Modelling, by Vic Smeed. *Model and Allied Publications*

Building a Ship in a Bottle, by Raymond F. Biggs. *Bailey Bros.*

How to Make Clipper Ship Models, by E. W. Hobbs. *Brown Son and Ferguson*

How to Make Old Time Ship Models, by E. W. Hobbs. *Brown Son and Ferguson*

Model Boat Construction, by P. W. Blandford. *Foyle Handbook*

Model Boats Radio Control Handbook. *Model and Allied Publications*

Model Power Boats, by R. H. Warring. *Arco*

Modelling the Cutty Sark. *Model and Allied Publications*

Modelling the Revenge. *Model and Allied Publications*

Modelling Tudor Ships, by R. K. Battson. *Model and Allied Publications*

The Observer's Book of Ships, by F. E. Dodman. *Warne,* (Pocket reference book).

Period Ship Modelling, by R. K. Battson. *Model and Allied Publications,* (How to build an Elizabethan galleon).

Picture Book of Ship Models, by G. P. B. Naish. *H.M.S.O.*

Power Driven Ship Models, by A. D. Trollope. *Model and Allied Publications*

Power Model Boats, by Vic Smeed. *Model and Allied Publications*

Ship Models, by B. W. Bathe, in three parts. *H.M.S.O.* *each part.* (Obtainable at Science Museum, South Kensington, London, S.W.7).

Ships. *Macdonald,* **(Junior Reference Library).**

Ships, by F. G. Kay. *John Baker,* (**It's Made Like This** series).

Solarbo Book of Balsa Models. *Model and Allied Publications*

Model Boats, (Monthly magazine).

Go to your public library for:

Shipbuilding and Design, by R. F. Serbutt.

Ships and Shipbuilding, by J. N. T. Vince.

To buy any of the above books, first try your local bookseller. If he does not have it in stock, he will be pleased to order it for you. In case of difficulty, write to the publisher of the book in question.

POSSIBLE CAREERS

MARINE ENGINEERING—making, installing and looking after ships' engines and machinery. Sea-going marine engineers train with the Royal Navy or the Merchant Navy. Enter the engineer branch of the Royal Navy as a graduate in mechanical or electrical engineering, or at the age of 17 to 19½ with 'O' and 'A' levels, or at school-leaving age (from 15¾) as artificer apprentice.

A would-be Merchant Navy engineer officer needs at least four 'O' levels, including mathematics and a science subject, before being accepted for training. Non-sea-going marine engineers start their careers with ship-building firms either as graduates, technicians (needing usually four 'O' levels, including mathematics, English language and a science subject), or craftsmen on apprenticeships for which no formal educational qualifications are required.

Read: Royal Navy, Choice of Careers Booklet No. 54 (from booksellers or Her Majesty's Stationery Office); **Technical Careers in the Royal Navy** (from Director of Naval Careers Service, Ministry of Defence, Old Admiralty Building, Whitehall, London S.W.1); **Merchant Navy Officers; Merchant Navy Ratings,** Choice of Careers Booklets Nos. 72 and 73 (from booksellers and Her Majesty's Stationery Office).

Write to: Institution of Marine Engineers, The Memorial Building, 76 Mark Lane, London E.C.3.

NAVAL ARCHITECTURE—designing and supervising the building of ships. Naval architects concerned with warships are recruited from apprentices in naval dockyards, naval officers already specialising in engineering, university graduates, employees of private shipyards, and school-leavers with good 'A' levels in pure mathematics, applied mathematics and physics. Shipbuilding firms also employ naval architects, who may have gone through the firm's apprenticeship scheme.

Read: The Royal Corps of Naval Constructors (from Ministry of Defence [Navy], Room 88, Empire Hotel, Bath); **A Career as a Naval Architect** (from Royal Institution of Naval Architects, 10 Upper Belgrave Square, London S.W.1).

MODEL-MAKING—production of small-scale models in many kinds of materials, for architects, town planners, film sets, museums and exhibitions. Entry is usually from 16 upwards, after a technical college or art school course.

Read: Model Making as a Career, by T. W. Hendrick (Percival Marshall); **Model Engineer,** a weekly periodical.

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PROJECT BOOKS

continued from inside front cover

continued from P. 64